FORM PTO-1390 (REV. 11-2000) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
3286-0163P	
U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	
09/914193 NEW	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/00576	February 25, 2000	February 26, 1999

TITLE OF INVENTION
VACUUM SWITCHING CHAMBER HAVING AN ANNULAR INSULATOR

APPLICANT(S) FOR DO/EO/US
KURZMANN, Harald; MAREK, Kathrina; OBERNDORFER, Klaus; RENZ, Roman; BANGHARD, Johannes-Gerhard; FIEBERG, Klemens; HAHN, Michael; HARTMANN, Werner; SCHMIDT, Detlev; *

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau). WO 00/52719
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98-International Search Report (PCT/ISA/210) w/ 10 documents
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☒ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
    1.) One (1) sheet of Formal Drawings

* KUSSEROW, Jorg

JC05 Rec'd PCT/PTO 24 AUG 2001

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/914193 NEW	PCT/DE00/00576	3286-0163P

21. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO..... **$1,000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)..... **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	4 - 20 =	0	X **$18.00**	$ 0	
Independent Claims	1 - 3 =	0	X **$80.00**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		None	+ **$270.00**	$ 0	
			TOTAL OF ABOVE CALCULATIONS =	$ 990.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$ 0	
			SUBTOTAL =	$ 990.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ 0	
			TOTAL NATIONAL FEE =	$ 990.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 0	
			TOTAL FEES ENCLOSED =	$ 990.00	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of $ **990.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account. No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2448.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
Birch, Stewart, Kolasch & Birch, LLP or Customer No. 2292
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Date: August 24, 2001

By _____ #35,094
Donald J. Daley, #34,313

/cgc

PATENT
3286-0163P

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Harald KURZMANN et al.

Application No.: **NEW**

Filed: August 24, 2001

For: VACUUM SWITCHING CHAMBER HAVING AN ANNULAR INSULATOR

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

August 24, 2001

Sir:

The following preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE ABSTRACT

Please replace the Abstract with the attached revised Abstract.

IN THE SPECIFICATION

Please replace the original specification with the Substitute Specification attached hereto.

IN THE CLAIMS

Please replace the original claims with the following new claims:

1. (Amended) A vacuum switching chamber for switching short-circuit currents in the low-voltage range, including a stationary contact tip and a contact tip which can move axially with respect to the stationary contact tip, each contact tip including an associated power current

connection, comprising:

an enclosure which surrounds the contacts, with the power current connection of the moving contact tip being in the form of a cylindrical bolt, the enclosure including rigid metal parts, an annular insulator and a resilient gas-tight metallic separating wall, connected to one another in an arrangement and connected in a gas-tight manner to the power current connections of the contact tips, and surrounding one of the rigid metal parts together with both the stationary contact tip and the moving contact tip, wherein the power current connection of the stationary contact tip is in the form of a plate, the metal part which surrounds the two contact tips is tubular and is connected at the end to the plate, and wherein the resilient, metallic separating wall includes a membrane which is provided with concentric corrugations, is in the form of a disk, and is soldered on one side to the power current connection of the moving contact tip and on the other side via an axially running annular flange to the annular insulator.

2. (Amended) The vacuum switching chamber as claimed in claim 1, wherein, for a switching movement of 3 to 5 mm, the membrane includes:

a wall thickness s of between 0.1 and 0.2 mm,

a corrugation depth t of approximately half the switching movement, and

a number Z of full corrugations, all of which satisfy the condition $Z \tau 1 +$ integer $(\sqrt[3]{\ } [(D_A - D_B) * s])$, at least 3, where D_A = external diameter of the membrane, D_B = diameter of the power current connecting bolt of the moving contact tip, and s = thickness of the membrane.

3. (Amended) The vacuum switching chamber as claimed in claim 1, wherein the contact tips are in the form of flat spiral contacts.

Please add the following new claim:

-- 4. The vacuum switching chamber as claimed in claim 2, wherein the contact tips are in the form of flat spiral contacts. --

REMARKS

Claims 1-4 are now present in this application, with new claim 4 being added by the present Preliminary Amendment. It should be noted that the amendments to original claims 1-3 of the present application are non-narrowing amendments, made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations. For example, amendments have been made to remove reference numerals in the claims; remove the European phrase "characterized in that"; remove multiple dependencies in the claims; and to place claims in a more recognizable U.S. form, including the use of the transitional phrase "comprising" as well as the phrase "wherein". Again, all amendments are non-narrowing and have been made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations.

SUBSTITUTE SPECIFICATION

In accordance with 37 C.F.R. §1.125, a substitute specification has been included in lieu of substitute paragraphs in connection with the present Preliminary Amendment. The substitute specification is submitted in clean form, attached hereto, and is accompanied by a marked-up version showing the changes made to the original specification. The changes have been made in an effort to place the specification in better form for U.S. practice. No new matter has been

added by these changes to the specification. Further, the substitute specification includes paragraph numbers to facilitate amendment practice as requested by the U.S. Patent and Trademark Office.

CONCLUSION

Accordingly, in view of the above amendments and remarks, an early indication of the allowability of each of claims 1-4 in connection with the present application is earnestly solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Donald J. Daley at the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By: _____
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ABSTRACT OF THE DISCLOSURE

A new vacuum switching chamber is intended for power breakers in the low-voltage range and is distinguished by a compact form with a small physical height and a high switching capacity. Its enclosure includes a plate-like power current connection, a cylindrical wall part which surrounds flat spiral contacts, an annular insulator and a membrane disk with a centrally arranged power current supply bolt.

SUBSTITUTE SPECIFICATION

VACUUM SWITCHING CHAMBER HAVING AN ANNULAR INSULATOR

[0001] This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/DE00/00576 which has an International filing date of February 25, 2000, which designated the United States of America, the entire contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The invention relates to the field of electrical components, and is applicable, for example, to the design configuration of vacuum switching chambers whose enclosure has two cap-like metal parts and an annular insulator, and which are, for example, intended for switching purposes in the lower A.C. voltage range (up to 1000 V).

BACKGROUND OF THE INVENTION

[0003] In a known vacuum switching chamber of this type, the two cap-like metal parts, which are composed of copper, and one of which forms the actual switching area for the stationary contact tip and the axially moving contact tip, are connected in a vacuum-tight manner at the end of the tubular wall region to the annular insulator. In each case, they are connected by blade soldering. In order to allow this known vacuum switching chamber to reliably switch short-circuit currents in the range from 50 to 100 kA while having axial and radial dimensions which are as small as possible, a folding bellows is soldered by one of its ends to the contact bolts of the moving contact tip, and in the immediate vicinity of the latter, and is surrounded concentrically by the annular insulator; a cap-like protective shield at the bottom of the moving contact tip in this case protects the folding bellows against electrical loads. - This vacuum interrupter has no special shield for protection of the inner isolating gap which is formed by the annular insulator, since a relatively broad end surface of the annular insulator faces away from the contact region. - The power current connections of this known vacuum switching chamber are - as normal - in the form of bolts, which pass axially through the respective cap-like metal part. - The two contact tips are normally in the form of pot-type contacts; however, other known contact shapes may also be used (DE 44 22 316 A1). Another known contact shape is, for example, spiral contacts (spiral petal contacts) with, in particular, flat, plate-like contact electrodes, which are provided with slits running inward from the outer circumference. These slits may each comprise a straight section and a hole which passes through the contact surface (EP 0 532 513 B1).

[0004] Vacuum interrupters are already known as switching elements for low-voltage contactors, in which the folding bellows forms a part of the outer surface of the enclosure and in this case connected in a vacuum-tight manner on one side to the power current connection of the moving contact bolt and on the other side, at the end, to a short tubular insulator (DE 37 09 585 C2). A folding bellows may in this case be connected by blade soldering both to the insulator and to the power current connection of the moving contact bolt (DE 195 10 850 C1).

[0005] Furthermore, vacuum switches are known for shunt operation of D.C. electrolysis cells, which have to switch a current of about 4000 A with a switching voltage of about 4 volts, and in which cylindrical contacts are incorporated in planar, conductive end plates, in order to allow the switch to be electrically connected to electrical connecting rails. In this case, each contact is soldered in a vacuum-tight manner via a corrugated membrane in the form of a disk to an insulating ring, which is arranged concentrically about the switching path. In one case, a holder for a shield in the form of a short piece of tubing is incorporated in the soldered joint, (which is produced as a blade soldered joint by means of an axial annular flange) between the membranes and the insulating ring (US 4,216,360 A, DE 29 44 286 A).

[0006] For vacuum switches which are used as vacuum contactors for low voltage, it is also known for a membrane which is provided with two deep, concentrically arranged, corrugations also to be used instead of a folding bellows as a sprung closure part for the switching chamber, which allows the moving contact tip to move. The two parts of the transversely split power current connecting bolt of the moving contact are soldered to this region of the membrane in the central region of the membrane, which is planar (DE 27 25 092 A1).

SUMMARY OF THE INVENTION

[0007] The present invention is based on an object, for example, of further reducing the physical size of the known vacuum switching chamber, while at the same time increasing the switching capacity in the process.

[0008] In order to achieve this object, the invention proposes that the power current connection of the stationary contact tip is in the form of a plate, that the metal part which surrounds the two contact tips is tubular and is connected at the end to the plate, and that the resilient, metallic separating wall comprises a membrane which is provided with concentric corrugations, is in the form of a disk, and is soldered on one side to the power current connection (which is in the form of a bolt) of the moving contact tip and on the other side via an axially running annular flange to the annular insulator.

[0009] Such a configuration of the vacuum switching chambers leads to a flat shape with a physical height which is considerably less than that of conventional vacuum interrupters. A

contributory factor here is firstly the configuration of the one power current connection as a plate instead of a cylindrical bolt, as was normal in the past, with this plate at the same time forming an end cover for the intrinsically cylindrical switching chamber. Another contributory factor is the use of a corrugated membrane instead of the otherwise normal folding bellows.

[0010] In order to ensure the necessary number of switching operations (at least 10,000 for example) for a switching movement of about 3 to 5 mm with this abnormal use of a membrane for a vacuum switching chamber which is used in a low-voltage A.C. power supply system, the number and depth of the corrugations for the membrane have to be designed appropriately. For this purpose, a further refinement of the invention provides that, with a wall thickness of between 0.1 and 0.2 mm and a corrugation depth of approximately half the switching movement, the membrane has a number Z of full corrugations which is greater than 1 + integer of the cube root of the external membrane diameter D_A minus the power current connecting bolt diameter D_B multiplied by the wall thickness s of the membrane, but at least 3, with the individual dimensions to be used being in millimeters. The boundary condition mentioned above is expressed as a mathematically formulated relationship as follows:

$$Z \tau 1 + \text{integer}\left(\sqrt[3]{[(D_A - D_B) * s]}\right), \text{ at least } 3.$$

[0011] Such a configuration of the membrane allows the corrugation to be chosen such that the radius of curvature corresponds approximately to the switching movement, and the individual corrugation trough corresponds to a circular arc with a circumferential angle of about 90°. However, the corrugation may also be in the form of a sine wave with straight flanks.

[0012] The novel switching chamber can be refined further by design measures such as those already proposed in the prior German Patent Application 198 02 893.8. According to this document, the flat shape of the novel vacuum switching chamber can be pronounced to an even greater extent if the contact tips are in the form of spiral contacts, in particular flat spiral contacts. The use of spiral contacts also leads to better arc management, thus resulting in an improved switching capacity. For example, the use of flat spiral contacts with a diameter of about 90 mm allows short-circuit currents of up to about 130 kA to be switched. - Irrespective of the diameter of the spiral contacts, it is recommended that a vapor barrier in the form of a disk be positioned between the moving contact tip and the associated power current connecting bolt, which vapor barrier is composed, for example, of a chromium-nickel steel and which, for vacuum switching chambers with a small switching capacity, can possibly be used for mechanical reinforcement of the moving spiral contact, whose thickness is reduced.

[0013] The novel refinement of the vacuum switching chamber also allows direct connection of the stationary contact tip to the associated plate-like power current connection, thus ensuring optimum heat dissipation when using a connecting bolt with a large diameter for the moving contact tip. The overall compact shape means that there is no need for any special guidance for the connecting bolt for the moving contact tip, as has been normal in the past for vacuum interrupters for power breakers when using a plastic bush. This allows the vacuum switching chamber to be more highly thermally loaded.

[0014] The novel design of the vacuum switching chamber also allows all the individual parts - except for the annular insulator - to be constructed such that they are self-centering, so that all the individual parts can be soldered to one another in a single operation (closure soldering) without using any expensive and complex soldering forms. To this end, it is recommended that the stationary contact tip be connected via a short centering stub to the plate-like power current connection, while the moving contact tip is connected to the corrugated membrane, centered via the contact bolt.

[0015] The shape of the tubular part which surrounds the two contact tips - particularly when they are in the form of flat spiral contacts - depends on the respectively intended switching capacity. For low switching capacities from about 40 to 60 kA, this part may be in the form of a hollow cylinder. For higher switching capacities, that is to say for larger contact diameters, it is recommended that the tubular part be provided with a conical taper at the end facing the annular insulator; this allows the use of an insulator and a corrugated membrane having a considerably smaller diameter than that of the spiral contacts. - Irrespective of the shape of the tubular part, which is preferably composed of copper, it is recommended that this tubular part be provided with arc-resistant cladding on the inner wall in the region of the switching path, for example by using sheet-metal parts composed of a chromium-copper composite material, or by electrochemical plating with chromium.

[0016] The insulating ring which is arranged between the corrugated membrane and the tubular part of the enclosure can, in a known manner, be formed by appropriate configuration of its cross-sectional contour such that there is no need to arrange a shield for protection against the deposition of metal vapor particles. If, on the other hand, the insulating ring is carrying out only an insulating function, the tubular metal part may have an attachment which acts as a vapor shield, as has already been proposed per se in the prior German Patent Application 198 26 766.5. With the metal part having these two functions, the transition from the area associated with the enclosure to the area which is used as the vapor shield has a corrugated form, so that the metal part touches the end surface of the insulating ring only in the form of a line, and thus allows a type of blade soldering in this area.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Two exemplary embodiments of the novel switching chamber are illustrated in Figures 1 and 2, in which:

Figure 1 shows a cross section of the switching chamber, and

Figure 2 shows a plan view of the plate-like power current connection.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] In the illustrated vacuum switching chamber, the enclosure comprises an upper metallic plate 1 which acts as the power current connection and is composed of copper, a hollow-cylindrical wall part 3 which is butt-soldered to it and is composed of copper, an annular insulator 4, a corrugated membrane 5 which is arranged coaxially with respect to the annular insulator 4, and a cylindrical power current connecting bolt 2. In this case, the annular insulator is designed in the same way as the insulator according to DE 44 22 316 A1, that is to say with an approximately square cross section and with a chamfer and an undercut. A stationary flat spiral contact 6 and a moving flat spiral contact 7 are arranged within the enclosure. The spiral contact 6 is connected to the plate 1 via a short centering stub 61, which engages in a centering hole in the spiral contact. The spiral contact 7 is seated on a centering attachment 21 on the power current supply bolt 2, which attachment acts as a constriction to the current flow. This is soldered at its other end to the corrugated membrane 5, in the region of a centering attachment 22. The membrane 5 is itself soldered to the insulator 4 via the axially running annular flange 51. This annular flange can be formed integrally with the membrane. - A vapor barrier 9 in the form of a flat disk composed of a mechanically strong material such as chromium-nickel steel is also arranged between the moving spiral contact 7 and the power current supply bolt 2. This vapor barrier 9 is used to shadow the annular insulator 4 from metal particles released from the spiral contacts 6 and 7 during the switching process.

[0019] The construction of the vacuum switching chamber is chosen such that all the individual parts can be soldered to one another in the course of a single soldering process. The degassing gaps required for this purpose can be provided with means, which are known from the prior art, in the joint region between the annular insulator 4 and the hollow-cylindrical wall part 3.

[0020] In the illustration shown in Figure 1, two different embodiments are illustrated of the tubular metal part which is arranged between the plate-like power current connection 1 and the annular insulator 4. In the left-hand part of the illustration, a tubular part 3 is provided as the wall part, whose ends are soldered firstly to the metallic plate 1 and secondly to one end surface in the annular insulator 4; in the right-hand part of the illustration, the wall part 31 is formed integrally with a shield 32, and is slightly corrugated in the transitional region from

the wall part to the shield. In addition, an insulating ring 41 which has a simple, rectangular cross section is used in the right-hand part of the illustration. - Furthermore, Figure 1 shows two different embodiments for the connection of the corrugated membrane 5 to the power current connecting bolt 2. In the left-hand illustration, blade soldering on the circumference of the power current connecting bolt 2 is provided, while, in or in the illustration on the right-hand side, the corrugated membrane 52 is soldered to the power current connecting bolt 2 in the region of a centering shoulder. Furthermore, an annular flange 51 which is welded to the membrane is provided in the left-hand illustration, while the annular flange is formed integrally with the membrane in the right-hand illustration.

[0021] Figure 2 shows a plan view of the plate 1, which acts as the power current connection, for the vacuum switching chamber shown in Figure 1. Rectangular or square shaping of the planar plate 1 leaves sufficient space for holes 11, which are used to attach the power current connection to a corresponding part of an associated switching device.

[0022] The membrane shown in Figure 1 may, for example, have the following dimensions:

External diameter: D_A: 77 mm

Internal diameter (diameter of the power current connecting bolt):

D_B: 25 mm

Wall thickness: s: 0.2 mm

Corrugation depth (distance between the corrugation peak and the corrugation trough): t: 2 mm

Number Z of corrugations: ≥3.

[0023] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Description

Vacuum switching chamber having an annular insulator

The invention relates to the field of electrical components, and is applicable to the design configuration of vacuum switching chambers whose enclosure has two cap-like metal parts and an annular insulator, and which are intended for switching purposes in the lower A.C. voltage range (up to 1000 V).

In a known vacuum switching chamber of this type, the two cap-like metal parts, which are composed of copper, and one of which forms the actual switching area for the stationary contact tip and the axially moving contact tip, are connected in a vacuum-tight manner at the end of the tubular wall region to the annular insulator, in each case by means of blade soldering. In order to allow this known vacuum switching chamber to reliably switch short-circuit currents in the range from 50 to 100 kA while having axial and radial dimensions which are as small as possible, a folding bellows is soldered by one of its ends to the contact bolts of the moving contact tip, and in the immediate vicinity of the latter, and is surrounded concentrically by the annular insulator; a cap-like protective shield at the bottom of the moving contact tip in this case protects the folding bellows against electrical loads. - This vacuum interrupter has no special shield for protection of the inner isolating gap which is formed by the annular insulator, since a relatively broad end surface of the annular insulator faces away from the contact region. - The power current connections of this known vacuum switching chamber are - as normal - in the form of bolts, which pass axially through the respective cap-like metal part. - The two contact tips are normally in the form of pot-type contacts; however, other known

contact shapes may also be used (DE 44 22 316 A1). Another known contact shape is, for example, spiral contacts (spiral petal contacts) with, in particular, flat, plate-like contact electrodes, which are provided with slits running inward from the outer circumference. These slits may each comprise a straight section and a hole which passes through the contact surface (EP 0 532 513 B1).

Vacuum interrupters are already known as switching elements for low-voltage contactors, in which the folding bellows forms a part of the outer surface of the enclosure and in this case connected in a vacuum-tight manner on one side to the power current connection of the moving contact bolt and on the other side, at the end, to a short tubular insulator (DE 37 09 585 C2). A folding bellows may in this case be connected by blade soldering both to the insulator and to the power current connection of the moving contact bolt (DE 195 10 850 C1).

Furthermore, vacuum switches are known for shunt operation of D.C. electrolysis cells, which have to switch a current of about 4000 A with a switching voltage of about 4 volts, and in which cylindrical contacts are incorporated in planar, conductive end plates, in order to allow the switch to be electrically connected to electrical connecting rails. In this case, each contact is soldered in a vacuum-tight manner via a corrugated membrane in the form of a disk to an insulating ring, which is arranged concentrically about the switching path. In one case, a holder for a shield in the form of a short piece of tubing is incorporated in the soldered joint, (which is produced as a blade soldered joint by means of an axial annular flange) between the membranes and the insulating ring (US 4,216,360 A, DE 29 44 286 A).

For vacuum switches which are used as vacuum contactors for low voltage, it is also known for a membrane which is provided with two deep, concentrically arranged, corrugations also to be used instead of a folding bellows as a sprung closure part for the switching chamber, which allows the moving contact tip to move. The two parts of the transversely split power current connecting bolt of the moving contact are soldered to this region of the membrane in the central region of the membrane, which is planar (DE 27 25 092 A1).

Against the background of a vacuum switching chamber having the features of the pre-characterizing clause of patent claim 1 (DE 44 22 316 A1), the invention is based on the object of further reducing the physical size of the known vacuum switching chamber, while at the same time increasing the switching capacity in the process.

In order to achieve this object, the invention proposes that the power current connection of the stationary contact tip is in the form of a plate, that the metal part which surrounds the two contact tips is tubular and is connected at the end to the plate, and that the resilient, metallic separating wall comprises a membrane which is provided with concentric corrugations, is in the form of a disk, and is soldered on one side to the power current connection (which is in the form of a bolt) of the moving contact tip and on the other side via an axially running annular flange to the annular insulator.

Such a configuration of the vacuum switching chambers leads to a flat shape with a physical height which is considerably less than that of conventional vacuum interrupters. A contributory factor here is firstly the configuration of the one power current connection as a plate instead of a cylindrical bolt, as was normal in the past,

with this plate at the same time forming an end cover for the intrinsically cylindrical switching chamber. Another contributory factor is the use of a corrugated membrane instead of the otherwise normal folding bellows.

In order to ensure the necessary number of switching operations (at least 10,000) for a switching movement of about 3 to 5 mm with this abnormal use of a membrane for a vacuum switching chamber which is used in a low-voltage A.C. power supply system, the number and depth of the corrugations for the membrane have to be designed appropriately. For this purpose, a further refinement of the invention provides that, with a wall thickness of between 0.1 and 0.2 mm and a corrugation depth of approximately half the switching movement, the membrane has a number Z of full corrugations which is greater than 1 + integer of the cube root of the external membrane diameter D_A minus the power current connecting bolt diameter D_B multiplied by the wall thickness s of the membrane, but at least 3, with the individual dimensions to be used being in millimeters. The boundary condition mentioned above is expressed as a mathematically formulated relationship as follows:

$Z \tau 1 + \text{integer } (\sqrt[3]{[(D_A - D_B) \quad s]})$, at least 3.

Such a configuration of the membrane allows the corrugation to be chosen such that the radius of curvature corresponds approximately to the switching movement, and the individual corrugation trough corresponds to a circular arc with a circumferential angle of about 90°. However, the corrugation may also be in the form of a sine wave with straight flanks.

The novel switching chamber can be refined further by design measures such as those already proposed in the prior German Patent Application

198 02 893.8. According to this document, the flat shape of the novel vacuum switching chamber can be pronounced to an even greater extent if the contact tips are in the form of spiral contacts, in particular flat spiral contacts. The use of spiral contacts also leads to better arc management, thus resulting in an improved switching capacity. For example, the use of flat spiral contacts with a diameter of about 90 mm allows short-circuit currents of up to about 130 kA to be switched. - Irrespective of the diameter of the spiral contacts, it is recommended that a vapor barrier in the form of a disk be positioned between the moving contact tip and the associated power current connecting bolt, which vapor barrier is composed, for example, of a chromium-nickel steel and which, for vacuum switching chambers with a small switching capacity, can possibly be used for mechanical reinforcement of the moving spiral contact, whose thickness is reduced.

The novel refinement of the vacuum switching chamber also allows direct connection of the stationary contact tip to the associated plate-like power current connection, thus ensuring optimum heat dissipation when using a connecting bolt with a large diameter for the moving contact tip. The overall compact shape means that there is no need for any special guidance for the connecting bolt for the moving contact tip, as has been normal in the past for vacuum interrupters for power breakers when using a plastic bush. This allows the vacuum switching chamber to be more highly thermally loaded.

The novel design of the vacuum switching chamber also allows all the individual parts - except for the annular insulator - to be constructed such that they are self-centering, so that all the individual parts can be soldered to one another in a single

operation (closure soldering) without using any expensive and complex soldering forms. To this end, it is recommended that the stationary contact tip be connected via a short centering stub to the plate-like power current connection, while the moving contact tip is connected to the corrugated membrane, centered via the contact bolt.

The shape of the tubular part which surrounds the two contact tips - particularly when they are in the form of flat spiral contacts - depends on the respectively intended switching capacity. For low switching capacities from about 40 to 60 kA, this part may be in the form of a hollow cylinder. For higher switching capacities, that is to say for larger contact diameters, it is recommended that the tubular part be provided with a conical taper at the end facing the annular insulator; this allows the use of an insulator and a corrugated membrane having a considerably smaller diameter than that of the spiral contacts. - Irrespective of the shape of the tubular part, which is preferably composed of copper, it is recommended that this tubular part be provided with arc-resistant cladding on the inner wall in the region of the switching path, for example by using sheet-metal parts composed of a chromium-copper composite material, or by electrochemical plating with chromium.

The insulating ring which is arranged between the corrugated membrane and the tubular part of the enclosure can, in a known manner, be formed by appropriate configuration of its cross-sectional contour such that there is no need to arrange a shield for protection against the deposition of metal vapor particles. If, on the other hand, the insulating ring is carrying out only an insulating function, the tubular metal part may have an attachment which acts as a vapor shield, as has already been proposed per se in the

prior German Patent Application 198 26 766.5. With the metal part having these two functions, the transition from the area associated with the enclosure to the area which is used as the vapor shield has a corrugated form, so that the metal part touches the end surface of the insulating ring only in the form of a line, and thus allows a type of blade soldering in this area.

Two exemplary embodiments of the novel switching chamber are illustrated in Figures 1 and 2, in which:

Figure 1 shows a cross section of the switching chamber, and

Figure 2 shows a plan view of the plate-like power current connection.

In the illustrated vacuum switching chamber, the enclosure comprises an upper metallic plate 1 which acts as the power current connection and is composed of copper, a hollow-cylindrical wall part 3 which is butt-soldered to it and is composed of copper, an annular insulator 4, a corrugated membrane 5 which is arranged coaxially with respect to the annular insulator 4, and a cylindrical power current connecting bolt 2. In this case, the annular insulator is designed in the same way as the insulator according to DE 44 22 316 A1, that is to say with an approximately square cross section and with a chamfer and an undercut. A stationary flat spiral contact 6 and a moving flat spiral contact 7 are arranged within the enclosure. The spiral contact 6 is connected to the plate 1 via a short centering stub 61, which engages in a centering hole in the spiral contact. The spiral contact 7 is seated on a centering attachment 21 on the power current supply bolt 2, which attachment acts as a constriction to the current flow. This is soldered at its other end to the corrugated membrane 5, in the region of a centering attachment 22. The membrane 5 is itself soldered to the insulator 4 via the axially running annular flange 51. This

annular flange can be formed integrally with the membrane. - A vapor barrier 9 in the form of a flat disk composed of a mechanically strong material such as chromium-nickel steel is also arranged between the moving spiral contact 7 and the power current supply bolt 2. This vapor barrier 9 is used to shadow the annular insulator 4 from metal particles released from the spiral contacts 6 and 7 during the switching process.

The construction of the vacuum switching chamber is chosen such that all the individual parts can be soldered to one another in the course of a single soldering process. The degassing gaps required for this purpose can be provided with means, which are known from the prior art, in the joint region between the annular insulator 4 and the hollow-cylindrical wall part 3.

In the illustration shown in Figure 1, two different embodiments are illustrated of the tubular metal part which is arranged between the plate-like power current connection 1 and the annular insulator 4. In the left-hand part of the illustration, a tubular part 3 is provided as the wall part, whose ends are soldered firstly to the metallic plate 1 and secondly to one end surface in the annular insulator 4; in the right-hand part of the illustration, the wall part 31 is formed integrally with a shield 32, and is slightly corrugated in the transitional region from the wall part to the shield. In addition, an insulating ring 41 which has a simple, rectangular cross section is used in the right-hand part of the illustration. - Furthermore, Figure 1 shows two different embodiments for the connection of the corrugated membrane 5 to the power current connecting bolt 2. In the left-hand illustration, blade soldering on the circumference of the power current connecting bolt 2 is provided, while, in

or in the illustration on the right-hand side, the corrugated membrane 52 is soldered to the power current connecting bolt 2 in the region of a centering shoulder. Furthermore, an annular flange 51 which is welded to the membrane is provided in the left-hand illustration, while the annular flange is formed integrally with the membrane in the right-hand illustration.

Figure 2 shows a plan view of the plate 1, which acts as the power current connection, for the vacuum switching chamber shown in Figure 1. Rectangular or square shaping of the planar plate 1 leaves sufficient space for holes 11, which are used to attach the power current connection to a corresponding part of an associated switching device.

The membrane shown in Figure 1 may, for example, have the following dimensions:

External diameter:	D_A: 77 mm
Internal diameter (diameter of the power current connecting bolt):	D_B: 25 mm
Wall thickness:	s: 0.2 mm
Corrugation depth (distance between the corrugation peak and the corrugation trough):	t: 2 mm
Number Z of corrugations:	τ3

Patent Claims

1. A vacuum switching chamber for switching short-circuit currents in the low-voltage range,
comprising: a stationary contact tip and a contact tip which can move axially with respect to it, each having an associated power current connection,
and an enclosure which surrounds the contacts,
with the power current connection of the moving contact tip being in the form of a cylindrical bolt, and
with the enclosure having rigid metal parts, an annular insulator and a resilient gas-tight metallic separating wall,
and these enclosure parts being connected to one another in a specific arrangement and being connected in a gas-tight manner to the power current connections of the contact tips,
and surrounding one of the rigid metal parts together with both the stationary contact tip and the moving contact tip,
characterized
in that the power current connection of the stationary contact tip (6) is in the form of a plate (1),
in that the metal part (3) which surrounds the two contact tips (6, 7) is tubular and is connected at the end to the plate (1),
and in that the resilient, metallic separating wall comprises a membrane (5) which is provided with concentric corrugations, is in the form of a disk, and is soldered on one side to the power current connection (which is in the form of a bolt (2)) of the moving contact tip (7) and on the other side via an axially running annular flange (51) to the annular insulator (4).

2. The vacuum switching chamber as claimed in claim 1,
characterized

in that, for a switching movement of 3 to 5 mm, the membrane (5) has

- a wall thickness s of between 0.1 and 0.2 mm,
- a corrugation depth t of approximately half the switching movement, and
- a number Z of full corrugations, which satisfy the condition

$Z \tau 1 + \text{integer} (\sqrt[3]{[(D_A - D_B) \quad s]})$, at least 3,

where

D_A = external diameter of the membrane [mm]

D_B = diameter of the power current connecting bolt of the moving contact tip [mm] and

s = thickness of the membrane [mm].

3. Vacuum switching chamber as claimed in claim 1 or 2,
characterized
in that the contact tips are in the form of flat spiral contacts (6, 7).

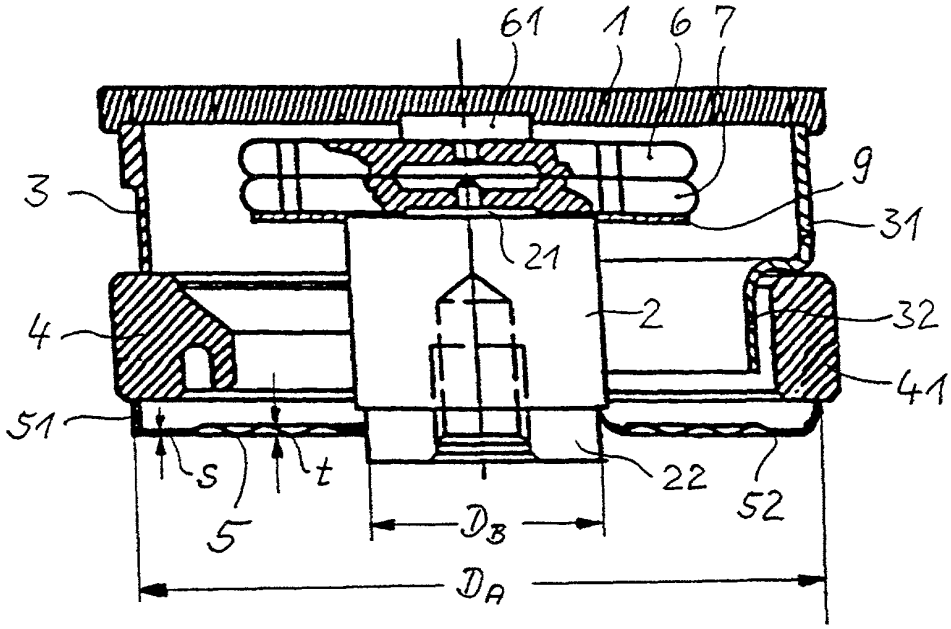

FIG 1

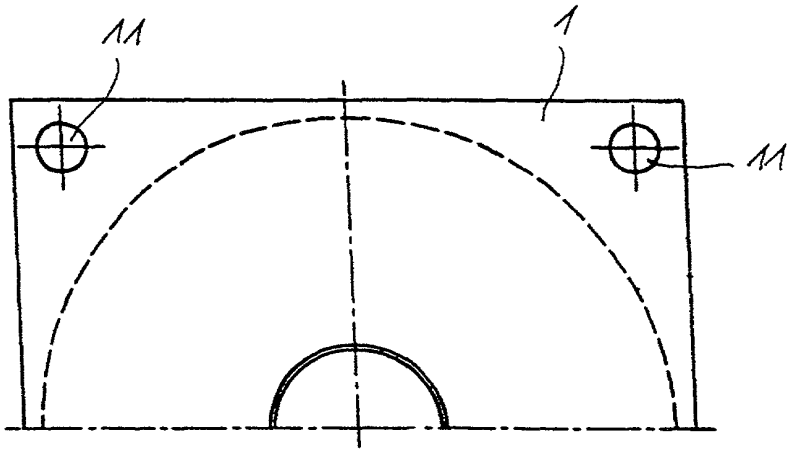

FIG 2

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Vakuumschaltkammer mit ringfoermigem Isolator

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 25.02.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/00576
eingereicht wurde und am _____
abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

VAKUUM INTERRUPTER CHAMBER WITH RING-SHAPED INSULATOR

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 25.02.2000 as
PCT international application
PCT Application No. PCT/DE00/00576
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Form PTO-FB-240 (8-83)
Patent and Trademark Office-U.S. DEPARTMENT OF COMMERCE

German Language Declaration

Prior foreign appplications Priorität beansprucht			Priority Claimed	
19910148.5 (Number) (Nummer)	DE (Country) (Land)	26.02.1999 (Day Month Year Filed) (Tag Monat Jahr eingereicht)	☒ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/00576 (Application Serial No.) (Anmeldeseriennummer)	25.02.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	anhängig (Status) (patentiert, anhängig, aufgegeben)	pending (Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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POWER OF ATTORNEY: As a name[illegible] hereby appoint the following attorne[illegible] agent(s) to prosecute this application and [illegible] business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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POWER OF ATTORNEY

The Declaration submitted along with this application includes a Power of Attorney listing the attorneys of Birch, Stewart, Kolasch & Birch, LLP. Please hereby revoke the aforementioned attorneys and substitute the attorneys of Customer No. 30596, including the following attorneys of Harness, Dickey & Pierce, P.L.C., to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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Donald J. Daley	Registration No. 34,313
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The undersigned is empowered with full Power of Attorney on behalf of the assignee.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C

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PATENT
32860-000163/US

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant:	Harald KURZMANN et al.	Conf. No.:	9466
Application No.:	**09/914,193**	Group:	Not Assigned
Filed:	August 24, 2001	Examiner:	Not Assigned
For:	VACUUM SWITCHING CHAMBER HAVING AN ANNULAR INSULATOR		

CHANGE OF ADDRESS AND REVOCATION AND SUBSTITUTION OF POWER OF ATTORNEY

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

December 17, 2001

Sir:

Under 37 C.F.R. § 3.73(b), the undersigned hereby states that the below-named Assignee is an assignee in the above-identified Application:

Assignee: **SIEMENS AKTIENGESELLSCHAFT**

The documentary evidence of a chain of title from the original owner to the Assignee is provided in the Assignment Document(s):

☒ filed herewith,

☐ previously filed,

Reel No. _____, Frame No. _____.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.